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Agricultural Research

At Boston, a Model Facility for Research on Aging

Aging is a physical process of gradually diminished functioning, but as many have noted, the aging process varies greatly from person to person. Some people age "well" and enjoy vitality and good health. Others must cope with osteoporosis, cataracts, arteriosclerosis, decreased function of the immune system, and loss of physical capacity—debilitating conditions too often associated with aging.

Nutrition scientists have long speculated that what an individual eats has a considerable effect on aging and health. Consequently, they are anxious to explore how diet—alone and in association with other genetic, physiological, sociological, and environmental factors—can delay or prevent the onset of degenerative conditions.

In 1978, USDA's Agricultural Research Service, in cooperation with Tufts University, established the Human Nutrition Research Center on Aging in Boston, Massachusetts, to try to improve the quality of life for the elderly.

The challenge is there. The United States has the third largest elderly population (65 plus) in the world, surpassed only by China and India. We also have the world's largest population of "old-elderly": people over age 80. While average life expectancy continues to increase—a substantial credit to our progress in health care and in nutrition—we shouldn't lose sight of the fact that 80 percent of our elderly have at least one chronic debilitating condition.

On the average, individuals over the age of 75 make eight visits to their doctors every year, and in 1985, about 5 million elderly in the United States required long-term care. And the cost of health-care continues to rise.

The Boston center, newest of ARS' five human nutrition centers and the only one to specialize in nutritional needs of the elderly, moved into a new 15-story building in November 1982.

Designed with research in mind, the 200,000-square-foot building houses the latest laboratories adaptable for biochemical, physiological, pathological, and behavioral studies for both human investigations and relevant experimental animal research. Equipment includes sophisticated instrumentation such as a whole-body gamma counter to assess body composition. Each laboratory has access through terminals to a central computer facility.

At the heart of the facility are comfortable living quarters and recreation areas provided for volunteer subjects, who may stay at the center for months while participating in long-term dietary studies.

Scientific objectives of the Center are:

• To determine how nutritional factors influence degenerative conditions associated with aging;

• To determine the nutritional requirements necessary to obtain optimal, functional well-being for a maturing population, and how these requirements can change as aging alters energy metabolism and nutrient utilization; and

• To develop methods to investigate the nutrient needs of the elderly.

The Center has begun to fulfill its role in advancing public health. In 5 years, 55 studies have been completed. Since the first four volunteers were admitted on July 5, 1983, the staff has evaluated more than 14,500 people for participation in studies. Although most volunteers are between the ages of 59 and 68, the oldest is 94—and she's thus far been in six studies.

Discoveries range from a gene abnormality that could signal heart disease to the fact that overuse of antacids by the elderly can reduce vitamin B uptake from food. Scientists are zeroing in on how and why cataracts form, and what substances—such as vitamins and minerals—guard the eye's lens against damage from sunlight and oxygen. Because of this work, cataract surgery may be the treatment of last resort by the turn of the century.

Among many other promising studies in human nutrition, scientists are charting the biochemical cycle of coronary heart disease. [See *The ABC's of Coronary Artery Disease* on page 9 of this issue.]

One Man's Impact

The name Jose Vicente-Chandler may not be a familiar one beyond Pucrto Rico's shores unless you are a specialist in tropical agriculture. Until retiring in 1986, Vicente-Chandler led a small team of scientists that transformed the island's farming to more fully meet the needs of its people:

• Overcoming obstacles like steep pastures and tropical humidity, Vicente-Chandler made beef and milk production efficient on almost all-grass rations. The system avoids importing expensive feed concentrates and produces about 1,000 pounds of beef or 7,000 pounds of milk per acre each year. It has been used as a basis for the entire $200-million-a-year Puerto Rican cattle industry.

• Coffee plants normally need partial shade, but Vicente-Chandler's research showed that they can be grown in full sunlight and yield many more berries if planted close together and given proper fertilization and care. He also demonstrated that coffee can be more easily and cheaply harvested by simply allowing the berries to fall as they ripen into plastic nets placed under the trees rather than by handpicking. Five to ten times more marketable coffee per acre results from these innovations.

In recognition of these and a lifetime of achievements, Jose Vicente-Chandler is to be inducted into the Agricultural Research Service Science Hall of Fame on June 21, 1988 in Beltsville, Maryland.

Agricultural Research

Cover: In Puerto Rico, plant geneticist Keith Schertz and other scientists from ARS and the Texas State Agricultural Experiment Station are breeding grain sorghums that will thrive in the tropics as well as the temperate zones. Bags prevent sorghum flowers from cross-pollinating, making it easier to breed for desired traits. Story on page 6. Photo by Bob Bjork. (0287X052-7)

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DEPARTMENTS

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Varroa, Nemesis of the Beehive

A honey bee mite causing the worst bee disease known has spread to as many as 13 states. To combat the blood-sucking pest, the Agricultural Research Service has instituted a crash research program.

The varroa mite *(Varroa jacobsoni)* threatens beekeepers and farmers who depend on bees for pollination. To thwart the deadly mites, ARS scientists are looking for both chemical weapons and nonchemical biological ones, such as fungi, viruses, and bacteria.

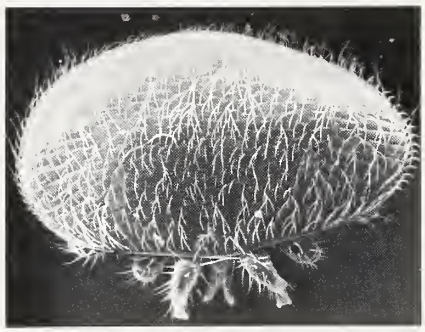
According to Hachiro Shimanuki, who headed the project, scientists with the Beneficial Insects Laboratory in Beltsville, Maryland, plan to study mite development to possibly formulate growth inhibitors.

"The mite is a serious problem for the bee industry," says Ralph A. Bram, of ARS' national program staff. "It reduces honey production and pollination, and within 2 to 3 years can kill all the bees in a hive."

"At this time, mite-free states will not allow farmers to rent bees from the 13 infested states because of fear the mite will spread. This calls into question the fate of crops such as peaches and almonds that depend on honey bees for pollination," he says.

The same fear could destroy the $30- to $50-million-a-year industry that sells packaged bees and queens to other countries. Already, Mexico has refused 4,100 queen bees sent by a U.S. producer to replace queens in colonies that had been taken over by Africanized bees. Canada—which buys half of U.S. bees—has followed suit.

The mite, which came from Asia, was first confirmed in Wisconsin, then in Florida, Pennsylvania, Ohio, Illinois, New York, Nebraska, South Dakota, Michigan, Washington, South Carolina, Mississippi, and Maine. "We think it's been here for 2 or 3 years, but nobody knows for sure," Bram says. Several states have destroyed infested hives and may have gotten rid of the pest, but there's still threat a of reinfestation.



The varroa mite parasitizes honeybee larvae as they develop in the brood comb. The reddish, pinhead-size female also parasitizes adult bees. (PN 7070)

The mite is especially harmful because it attacks both adult bees and larvae developing in honeycomb cells. Most diseases attack only one or the other stage. The female varroa mite lays 3 to 20 eggs in the protective comb cell of a developing bee. Young mites emerge and suck the blood of bee larvae.

"Some bee pupae survive but emerge as deformed adults, useless to the hive. These will be killed by worker bees," Shimanuki says. In the winter, when bees don't have larvae in cells, mites parasitize adults by attaching to their abdomens and sucking their blood.—By **Jessica Morrison,** ARS.

Hachiro Shimanuki is with the USDA-ARS Beneficial Insects Research Laboratory, Room 101, Bldg. 476, BARC-East, Beltsville, MD 20705 (301) 344-2205. ♦

Mosquito Larvae Are Color Coded

They can make their tiny bodies black, white, or somewhere in between—depending on the color of their surroundings. What the young anopheline mosquitoes are doing, scientists think, is matching their bodies to their environment to survive among enemies.

And what Agricultural Research Service entomologists are doing is looking for the gene that controls the newly discovered color change. If they find it, they'll design a new system for sterilizing this mosquito—known in the United States as a biting pest and in South and Central America as a malaria vector.

After noticing a color difference in larvae from different areas in a lake, Mark Q. Benedict and Jack A. Seawright raised larvae in white and black pans in the laboratory. Result: white larvae and jet black larvae.

The scientists believe larvae produce more pigment in dark environments. "We think the color change is an evolutionary mechanism to protect larvae from their enemies," Benedict says. "After all, if they can't be seen, they can't be eaten."

If Benedict and Seawright find a gene that controls pigment, they will cut off its promoter—the part that prompts pigment production to begin when the larva is in a dark environment—and attach it to a sterility gene. "We don't have a sterility gene now, but it should be easy to find," Benedict says.

They could then put the new gene, engineered with pigment promoter plus sterility, in mosquito eggs. Result: larvae that when raised on dark containers, sterilize themselves. "We could release nonbiting sterilized males into the wild to mate with females and cut down the population," he says. Both scientists work for USDA's Agricultural Research Service.

This color phenomenon, called homochromy, was previously unknown in the fly and mosquito insect group. Scientists have known for some time, however, that some insects in the grasshopper family have this color-changing ability.

With mosquitoes, Benedict and Seawright found that the transformation from white to black in dark pans was gradual, with the larvae going through intermediate brown stages until they matched the black pan.

Brown larvae, put back into a white pan, stop producing pigment and stay as they were. And black and white larvae put in the middle of a dual-colored pan tended to wriggle to the side painted the color of their bodies.—By **Jessica Morrison,** ARS.

Mark Q. Benedict and Jack A. Seawright are with the USDA-ARS Insects Affecting Man and Animals Research Laboratory, 1700 S.W. 23rd Drive, Gainesville, FL 32604 (904) 374-7998. ♦

Super Carrots, Healthful Carrots

What's up, doc? Carrot consumption in the United States...and the number of varieties of the popular vegetable, thanks to an Agricultural Research Service breeding program.

Under the leadership of Philipp W. Simon, plant breeders at the USDA-ARS Vegetable Crops Research Laboratory in Madison, Wisconsin, are rooting for carrot stick crunchers and carrot cake cravers alike. Their research, which carries on the work of the late Clinton Peterson, a noted research horticulturist, has brought forth dozens of specially bred carrots.

Varieties of ARS carrots are grown coast to coast. Orlando Gold is an adaptable variety that especially thrives in the warm winters and organic soils of Florida, while Golden State, a carrot for all seasons, is prized by commercial growers in California.

In addition to virtues like noteworthy flavor and disease resistance, these carrots have been bred for strong tops. Although consumers may consider a carrot top to be the ultimate throwaway, it's important to commercial growers. Most carrots grown commercially in the United States are mechanically harvested; weak-topped varieties are prone to break when lifted by machine, a costly waste.

To find out how ARS-bred carrots score for flavor, some of the most promising were entered in a recent taste-test competition in California.

A panel of 15 judges munched and measured their way through 122 varieties, ranking them according to flavor, yield, and appearance. ARS entries took the top 28 spots and 45 of the first 50.

This is good news for domestic carrot consumers, who now have better carrots to feed their growing appetites. According to vegetable situation analyst Shannon Hamm of USDA's Economic Research Service, Americans went through a healthful 7.8 pounds of fresh carrots per person in 1986, up from 6 pounds in 1970. Producers must also think about a small but significant export market; about 3 percent of today's crop is sold in Canada. And on the horizon, there are plans to export U.S.-grown carrots to Japan.

Consumer appeal isn't the only thing that ARS plant breeders strive for. One experimental line, Beta III, has earned the nickname Super Carrot because it contains three to five times the usual amount of beta carotene, the raw material that the body converts into vitamin A.

To the millions of children in underdeveloped countries who suffer vision impairment due to vitamin A deficiency, Super Carrot's carotene bounty provides hope for better nutrition. Field tests are currently underway in South Asia, Central Africa, and Central America to adapt it to local soil conditions.—By **Regina Wiggen**, ARS.

Philipp W. Simon is at the USDA-ARS Vegetable Crops Research Lab., Univ.of Wisconsin, Madison, WI 53706 (608) 262-1490. ♦

More Grama Grass With Atrazine

Atrazine, a commonly used herbicide, mysteriously increases yield of blue grama grass by as much as 63 percent when applied at rates as low as one-half pound per acre. This increased yield cannot be accounted for simply by the chemical's action as a weed killer.

It's a known fact that, when applied at rates of 2 to 4 pounds per acre, atrazine kills annual weeds in cornfields by disrupting photosynthesis. But lesser amounts seem to have different beneficial effects—low-dose applications somehow stimulate growth of blue grama and other grasses that thrive in warm weather.

The phenomenon is now under study at ARS' Great Plains Systems Research unit, Fort Collins, Colorado. Researchers hope to determine the optimum application rate for maintaining diversity of range plants and increasing forage yield. They are also studying what happens to the herbicide after annual or semi-annual applications and atrazine's impact on plant and soil environment.

Marvin C. Shoop, an ARS range scientist, ventures an educated guess about how low concentrations of atrazine work to promote growth. "Pastures treated with atrazine had up to 2-1/2 times greater ratios of nitrate to ammonium nitrate than pastures not treated. This strongly suggests that the herbicide alters microbial changes of nitrogen form in the soil. The herbicide may be making additional nitrogen available to blue grama, or it may be enhancing uptake of nitrate by plants," he says. ARS scientists at Fort Collins are now studying how atrazine affects soil nitrogen, as well as other basic aspects of how atrazine increases growth of blue grama.

The increased yield is not explained by atrazine's weedkilling function, whereby competition for nutrients and water is reduced. Weeds would not have been a problem even without atrazine in 6 out of 7 years Shoop says about tests on the Central Plains Experimental Range near Nunn, Colorado.

This increase in valuable warm season forage production, without application of commercial fertilizers, could spell higher net profits for beef producers. Cattle graze some 140 million acres of the Central and Northern Great Plains.

About 80 percent of these rangelands are in fair to poor condition. Atrazine shows promise of restoring productivity to once-rich lands, controlling weeds and at the same time stimulating warm-season grasses.—By **Dennis Senft,** ARS.

Marvin C. Shoop is with the Great Plains Systems Research Unit, Crops Research Laboratory, 1701 Center Ave., Fort Collins, CO 80526 (303) 484-8777. ♦

Taking the Initiative in Puerto Rico

Change comes slowly to Puerto Rico. Sugarcane was introduced to the island's fertile soil in 1515; it took more than three centuries for coffee to replace it as the number one crop. In recent times, an increasing number of tropical and subtropical food crops have won space in the field, each challenging the farmer with special problems: controlling diseases and insects, developing markets, and selecting the best mix of inputs.

"Today's farmer needs to be able to tackle many difficulties at once, to learn scientific farming," says Jose Vicente-Chandler, a long-time proponent of applied science in farming. To do this, farmers there are getting a hand from scientists like Vicente-Chandler, now retired from USDA's Agricultural Research Service .

Puerto Rican grown grain sorghum could replace about $30 million worth of feed corn imported yearly.

BOB BJORK

Above: On the dairy farm where she trained, Greisha Sievens discusses forage grasses with retired ARS scientist Jose Vicente-Chandler. (0287X056-11A)

Right: Trainee agronomist Evelio Hernandez (right) inspects new variety seedling coffee trees on the plantation of grower Felipe Ozonas. (0287X061-6)

BOB BJORK

Through a training and development project sponsored by the Agricultural Research Service, college graduates are getting a chance to apply their book learning to some meaningful hands-on experience, learning how to grow and manage these diverse crops on farms throughout the island.

Since early 1986, ARS has been providing this in-field experience in cooperation with the University of Puerto Rico. It's a contribution to the Caribbean Basin Initiative, an international project to revitalize regional economies.

"It's a good opportunity for qualifying students, from Puerto Rico and other Caribbean islands, to learn about and apply their knowledge to improve their homeland agricultural potential," says Antonio Sotomayor-Rios. He is the research leader at the ARS Tropical Agriculture Research Station, Mayaguez.

The Project is helping tropical agriculture, especially in the Caribbean, because that area lacks crop management generalists. "There are lots of specialists but few who can pull all the parts together," says Vicente-Chandler. "There are very few entrepreneurs to develop and manage modern farms," he says.

To produce a new generation of farmers, the program sets two tasks for the trainees. One is to work out in the field with farmers and fruit and vegetable companies and to acquire research experience at the experiment stations and then become efficient agricultural managers. The trainees also provide their sponsors with some of the knowledge they acquired at the University.

Their second task is to practice hypothetical farming. Given the basic facts about the farms, soils, slopes, temperature ranges, rainfall distribution, etc., the group has to figure out which crops to plant, where and which parts of the farm are best for each. The group also has to evaluate technical problems, costs, financing, and potential markets in their plan.

With a population nearly that of Kentucky, but with less than a tenth of its land area, Puerto Rico buys over 60 percent of its food from the U.S. mainland and from other countries, including virtually all of the feed grain needed for its livestock and poultry industry.

Keeping an eye on making the island more self-sufficient, scientists from ARS and the Texas Agricultural Experiment Station are developing and testing new grains that can thrive in Puerto Rico.

BOB BJORK

BOB BJORK

Above: The cassavas in foreground and the yams being examined by ARS horticulturists Heber Irizarry and Edmundo Rivera are the result of a 2-year study that shows how intercropping the two root crops can provide 60 percent more food carbohydrates from the same plot. The woody cassava plant forms a natural trellis for the yam vines. (0287X058-10A)

Left: Agronomist Lucas Ramirez trained on this farm on the south coast of Puerto Rico. Training is an ARS contribution to the Caribbean Basin Initiative. The farm grows and exports peppers, tomatoes, melons, and other crops. (0287X067-8)

Taking advantage of the mild climate at the winter nursery site at Isabela on the northwestern part of the island, ARS and state plant geneticists and agronomists are working on cereals that can grow both in the Tropics and the temperate zones.

For instance, ARS plant geneticist, Keith F. Schertz from Texas, works closely with ARS' Sotomayor-Rios, Salvio Torres-Cardona, and Paul Hepperly in the search for improved sorghum lines.

"Sorghum is versatile, drought-tolerant, and suitable for land previously devoted to sugarcane," says Hepperly, a plant pathologist. Puerto Rican sorghum could largely replace about $30 million worth of feed corn that must now be imported yearly to sustain dairy, egg, and meat production.

Texas A&M Experiment Station and ARS scientists also converted tall tropical sorghums that are sensitive to day length into short, daylight-insensitive strains that can grow year round in Puerto Rico by crossbreeding them with temperate zone sorghums. The resulting short hybrids are easy for farmers to machine-harvest, yet they have the drought and heat resistance inherent in tropical sorghum varieties.

The winter nurseries also serve as a site to grow out crosses of temperate and tropical corn, soybeans, and peanuts that will be studied in ARS labs in the United States. The year-round growing season of the Tropics allows generations of plants to be grown back to back, without the seasonal break dictated by winter in temperate regions.

True yams, a staple crop for many Puerto Ricans and about 150 million people worldwide, are also being studied at the site. They're not at all like sweetpotatoes, which are often called yams. True yams range from orange to a dark purple, and from the size of a sweetpotato to a large, bulbous tuber.

At Isabela, agronomist Francisco Vazquez is evaluating 11 varieties of the most popular yam, *Dioscorea alata.* He is looking for high-yielding varieties with resistance to anthracnose, a disease that burns yam vines.

Another project underway at the Corozal Agricultural Experiment Substation interplants yams with cassava, also a root crop. Tests by horticulturists Heber Irizarry and Edmundo Rivera show that growing the tubers together yields 60 percent more food carbohydrates per acre than yams alone. And the woody stems of the cassava plants provide support for yam vines, taking the place of costly wooden stakes or wire trellises.—By **Dvora Aksler Konstant,** ARS.

Antonio Sotomayor-Rios, Francisco Vazquez, Heber Irizarry, Edmundo Rivera, and Paul Hepperly are in USDA-ARS, Tropical Crops and Germplasm Research, Tropical Agriculture Research Station, P.O. Box 70, Mayaguez, PR 00709 (809) 834-2435. Keith F. Schertz is in USDA-ARS Cotton and Grain Crops Genetics Research, P.O. Box DN, College Station, TX 77841 (409) 260-9252. ♦

New Houseplants To Boost U.S. Floral Industry

A new dwarf species of a native American plant, an evergreen from Denmark, and a lily from Asia should be ready for U.S. consumers this year, an Agricultural Research Service scientist says.

All three species are houseplants: a 10-inch lisianthus, an evergreen of the cypress family that grows to about 18 inches in about a year, and a small hybrid lily that matures in a year from seed.

"We expect these plants to have a favorable impact on the floral industry. They are totally new plants for the American market," says Roger H. Lawson. He heads the agency's Florist and Nursery Crops Laboratory in Beltsville, Maryland.

Potted plants account for about a sixth of the U.S. greenhouse and nursery crops sales, estimated at $5.8 billion in 1986.

Lawson says that in developing the new houseplants, florist and nursery growers and university specialists evaluated them for 3 to 5 years in repeated growings as part of a new-crops program the agency and the industry established in 1984.

The goal is to search for, test, and introduce new plants that have market potential for the florist and nursery industries. "We transfer the results of our research to industry, and commercial growers evaluate whether a plant has sales appeal to the public," he says.

Some of the more than 60 plants in the program are:

Dwarf lisianthus. It reaches a mature height of less than a foot and has a single stem, some lateral branching, and smooth leaves.

The parent plant, *Eustoma grandiflorum* is considered a weed; it grows 2 to 3 feet tall in Nebraska, Texas, New Mexico, Louisiana, and Arizona.

Flowers of the new dwarf selection are purplish-blue. White and pink specimens are also being developed. Blooms are hardy and can last at least 14 days as cut flowers.

It needs plenty of light but little other care except for watering every 2 to 3 days. Outdoors, it can be used as a bedding plant and will bloom up to 2 months.

TIM McCABE

Cupressus. As a potted evergreen, *Cupressus marf,* Gold Crest, makes an ideal plant for the holidays. It is fragrant and grows to about 1 to 1-1/2 feet tall. Excess growth can be pinched off easily.

Plants can be grown on the windowsill in high or low light. They require water every 3 days. Heating vents or machines that generate lots of warm air may harm the plants.

Lilies. New Asiatic hybrid lilies are also being readied for distribution. Their flowers range from deep yellow to bright red. They can be grown from seed and should mature in less than a year. They will have thick flowers that remain in bloom for several days longer than regular lilies.

Horticulturist Mark S. Roh, who is in charge of the new-crops program at the Beltsville laboratory, says the dwarf

TIM McCABE

TIM McCABE

Top, left: Plant pathologist Roger Lawson (right) and horticulturist Mark Roh display new flowering plants they've collected and improved for the U.S. market. (88CN0867)

Above: Once a Texas weed, dwarf lisianthus may become an ideal potted or bedding plant. (88CN0866)

Left: Asiatic hybrid lilies are being bred in a wide range of colors from yellows to reds with multiple blossoms. (88CN0868)

lisianthus may be the first of the plants to be available to consumers.—By **Doris Sanchez,** ARS.

Roger H. Lawson and Mark S. Roh are in the USDA-ARS Florist and Nursery Crops Laboratory, Bldg. 004, BARC-West, Beltsville, MD 20705 (301) 344-3570. ♦

New Lima Bean Tolerates Drought Like a Camel

You would not expect a lima bean could make a camel look thirsty by comparison, but consider a scientist's new lima bean that flourishes on just drops of rainwater.

The bean, developed by Agricultural Research Service plant pathologist Charles A. Thomas, thrived last summer even though only three-quarters of an inch of rain fell in the 3 months after the bean was planted in June. The Beltsville (Maryland) Agricultural Research Center, where the test plot is located, normally gets 12.3 inches of rain between June 1 and August 31.

Despite far less than normal rain and no irrigation, the plants produced a "respectable crop of pods," says Thomas. "I find it hard to believe that these plants could do so well with so little water. But you can just look at them—the plants are green and full; the pods are big and almost ready to pick."

Not 10 feet away from the flourishing lima beans was a patch of corn, also planted June 1. The rows, barely waist high, were brown instead of green, burnt in a summer that had 21 days over 90 degrees.

Thomas is hoping that genetic engineering researchers will attempt to isolate the genes that give the new lima bean such a high degree of drought tolerance.

If such drought resistance can be conferred on other vegetables, it would mean incredible potential for growing crops in dry regions of the country and the world, says Howard J. Brooks, the agency's national program leader for horticulture.

Actually, the new lima bean's ability to handle drought caught Thomas by surprise. "I wasn't particularly selecting for that trait," he says. "I thought that field of beans had been irrigated until I checked."

But lima beans have always had some degree of drought tolerance, according to Thomas. Lima beans originated in Guatemala, and the Indians first brought them here through Arizona and New Mexico. So what varieties survived the arid conditions in those areas were naturally going to have some drought tolerance, which has been passed on.

TIM McCABE

Framed by drought-dried cornstalks, drought-resistant lima beans stand tall and lush in the September sun in a Beltsville, Maryland, test plot. (0987X1044-6)

While Thomas is pleased with his lima bean's camel-like water requirement, he is even happier that it combines two very marketable characteristics—a large curved pod and a bean that retains its green color after maturity. This combination was Thomas' original goal in the lima breeding program.

Other lima beans with large curved pods turn white after they reach mature size. Consumers don't seem to like white beans among their green ones, so processing plants cull the white beans. With this variety, no separation will be necessary, Thomas says.

"Best of all, though, is the flavor," Thomas says. "Most people I've fed these beans to like them better than any other lima."—By **Kim Kaplan,** ARS.

Charles A. Thomas is in the USDA-ARS Microbiology and Plant Pathology Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705 (301) 344-3354. ♦

The ABC's of Coronary Artery Disease

On the fifth floor of USDA's Human Nutrition Research Center on Aging at Tufts University in Boston, a group of scientists have gone back to studying the ABC's...in people's blood, that is.

It happens that the proteins that usher fats and cholesterol around the body—known as apolipoproteins, or apos for short—are named A, B, C, and E. The apos are essential for the lipids (fats and cholesterol) to dissolve in the water-based blood. By determining the normal distribution of A's, B's, and C's in a large population and identifying genetic glitches, members of the Lipid Metabolism Laboratory are working to establish a better measure of a person's risk for coronary artery disease—still the nation's No. 1 killer.

The cause of coronary artery disease—atherosclerosis—"is a clinically silent, slowly progressive process that results from factors that damage the arterial wall," says Ernst J. Schaefer, M.D., director of the laboratory.

One of those factors is the accumulation of excess cholesterol, caused by a high-fat diet. The process, he says, begins as early as the teen years with fatty streaks in and under the layer of cells that line artery walls, particularly the arteries in and close to the heart. It later graduates to plaques—a kind of fat-rich scar tissue that bulges into the arterial channel, partially blocking blood flow. If a blood clot gets caught on an advanced plaque in a coronary artery, blood flow may be blocked entirely, and a heart attack occurs. Or reduced blood flow can precipitate abnormal heart rhythms—tachycardia and fibrillation—sometimes causing sudden death.

Last October the National Heart, Lung and Blood Institute—a part of NIH—launched a national war on cholesterol under its National Cholesterol Education Program.

The program recommends that doctors monitor cholesterol levels in all American adults and urge patients to maintain a total serum cholesterol level below 240 milligrams per deciliter (mg/dL)—less than 200 mg/dL being ideal, says Schaefer, who served on the committee making the recommendations. Patients whose blood levels are above 240 mg/dL and those whose blood levels fall in the 200-240 mg/dL range and have two risk factors for heart disease (being male is one) should have their blood further analyzed for levels of low-density lipoproteins (LDL). These are thought to deposit excess cholesterol in arteries and have therefore been dubbed the "bad cholesterol." LDL should be kept below 160 mg/dL, according to the guidelines, and below 130 mg/dL is even better.

Schaefer and chemist Jose M. Ordovas believe that the apolipoprotein levels will be far more accurate than serum cholesterol levels in predicting risk of coronary artery disease. And they look to the day when doctors use apo tests to identify people at greater risk long before they develop smoking or eating habits that provoke the disease. To this end, Ordovas directs the staff in developing faster, more accurate and inexpensive assays for the major apos for use in medical labs around the country.

With their improved techniques, the Lipid Metabolism lab staff have analyzed the blood of 3,800 men and women in the Framingham (Massachusetts) Offspring Study. These are the sons and daughters of the men and women who participated in the landmark Framingham Heart Study, which began in 1950 to identify the causes of heart disease. Blood from the surviving individuals in the original study is also being analyzed for apo levels and compared with their LDL and HDL cholesterol levels.

Often called the "good cholesterol," HDL is thought to remove excess cholesterol from circulation, keeping it from being deposited in artery walls.

About 40 percent of the funding for this research comes from the National Heart, Lung, and Blood Institute. The study is the largest analysis of the major apos, says Ordovas, and is also being done on one of the the best characterized populations—one that has been followed for 38 years.

"We are using the Framingham Offspring Study to arrive at normal ranges for these apolipoproteins as well as a measurement of risk," says Schaefer. "Some 20 small studies indicate that the proteins are more accurate indicators of heart disease risk than LDL and HDL cholesterol."

For example, explains Ordovas, "the cholesterol and triglyceride content of LDL particles can vary, but each particle has only one apo B molecule. You're measuring something that's fixed." Apo B levels indicate the number of LDL particles in circulation, he says. "Cholesterol is a problem, but the number of LDL particles is a bigger problem."

Even among LDL particles there is a range in size from small and dense to large and buoyant. Small, dense LDL particles have been associated with premature (before age 60) coronary artery disease. They are thought to deposit the lion's share of cholesterol in artery walls because they can cross the arterial lining more readily, says Schaefer. "And the smaller the particles, the more you have," adds Ordovas. Chemist Judith R. McNamara led the group in studying the LDL profile of 280 men and women. She found that men and older people had small, dense LDL particles and higher levels of apo B far more often than women under 65. "The gender difference in LDL may

We believe that the apolipoprotein levels will be far more accurate than serum cholesterol levels in predicting risk of coronary artery disease...and look to the day when doctors use apo tests to identify people at risk long before they develop smoking or eating habits that provoke the disease.

Ernest J. Schaefer and **Jose M. Ordovas,** Human Nutrition Research Center on Aging, Boston, Mass.

explain some of the well-known differences in heart attack risk between men and women," says McNamara.

Ordovas says cholesterol is used as a marker for risk because it has been easy to measure. But researchers have seen normal LDL cholesterol levels in many patients with premature coronary artery disease who have elevated apo B levels. And Schaefer points out another potential cause of error is lack of precision in measuring cholesterol within LDL and HDL. While total cholesterol, HDL, and triglycerides are measured directly, LDL and VLDL (very low-density lipoprotein) cholesterol have to be calculated from these figures. "If a blood sample sits at room temperature, HDL can donate some of its cholesterol to other lipoproteins," says Schaefer.

In 2 days, the team ran a few hundred samples with standard laboratory equipment instead of just a few samples by the older method.

Jose M. Ordovas, Human Nutrition Research Center on Aging at Boston

Ordovas says his method for measuring apo B—which uses antibodies to the protein—is faster and more accurate than older methods. In 2 days, the team ran a few hundred samples with standard laboratory equipment instead of a few samples by the older method. "And it can be automated to run much faster," he adds.

Results from the entire Framingham study sample will be published later this year. Here's a sneak preview of findings from about one-third of the participants.

• The average level of apo B in 1,115 men and women was 89 mg/dL; the average level of LDL cholesterol for the same group was 133 mg/dL—about 3 mg above the ideal level for LDL cholesterol.

• Apo B levels increased with age, and males had consistently higher apo B concentrations than females up to age 65.

• Subjects with high apo B levels also had high triglyceride levels. This is not surprising since apo B is also a major protein of VLDL—the main carrier of triglycerides between meals. While high levels of VLDL are not a risk factor in themselves, they depress the beneficial HDL: when VLDL is high, HDL is low.

Genetic Glitches Can Signal Risk

Defects or mutations in the apos themselves can increase risk of coronary artery disease, Ordovas says. Three years ago he, Schaefer, and several foreign and domestic scientists discovered a gene abnormality that reduces a person's production of the predominant apo in HDL, apo A-I. (See *Agricultural Research,* August 1986, p. 13). Those who had the gene abnormality had less HDL cholesterol and a much higher rate of premature coronary artery disease than those who didn't. These studies are continuing in an effort to identify precise DNA markers for heart disease.

With the Framingham study subjects, Ordovas and colleagues have also looked at the effect of genetic mutations of apo E on blood levels of triglycerides and cholesterol. "A number of studies have demonstrated the association of different apo E types with lipid disorders," he says. The three types of apo E found most commonly in populations are E-2, E-3, and E-4. They differ from one another by a single amino acid.

Apo E is a major protein of chylomicrons. These large particles, laden with triglycerides, form in intestinal cells during a meal and travel to the liver to be reprocessed into other particles. Since the liver has specialized "docks," known as receptors, for apo E, the protein plays a major role in getting chylomicrons into the liver for reprocessing, says Ordovas. If the protein is altered because of a genetic mutation, it may slow down the clearance of triglycerides from the blood.

Based on the team's own tissue culture studies, "we know that apo E-3 is recognized by the liver most readily," says Ordovas. "If the liver is more prone to recognize one type of apo E," he says, "in the long term, that is going to produce different lipid levels in people with different types." Results from a preliminary look at about 1,100 Framingham study subjects bear this out. He says, "Our data indicate that apo E types significantly affect triglyceride and cholesterol levels in a normal population." To analyze so many samples, Ordovas and company developed an electrophoresis technique that costs much less than earlier techniques and produces results in 1 day instead of 1 week. "It makes an apo E assay available to practically every medical lab," he says.

With such a monumental study virtually complete, it may not be long before medical labs across the country will be reading our ABC's when we go in for a checkup.—By **Judy McBride,** ARS.

Ernst J. Schaefer and Jose Ordovas are at the USDA-ARS Human Nutrition Research Center on Aging at Tufts University, 711 Washington St., Boston, MA 02111 (617) 556-3311. ♦

Upcoming in the Next Issue

• High-technology ranching: With embryos being split, washed, and frozen, science has put a new twist on beef and milk production.

• Sweetpotato french fries: We tried them—they're good!

• Are cattle safe under high voltage wires? Researchers in Oregon say yes.

• The wonderful world of yeast: ARS scientists are learning to harness these fungi for new products—from antibiotics to enzymes that may help treat heart attack victims.

Circulation of Lipoproteins and Apolipoproteins in the Human Body

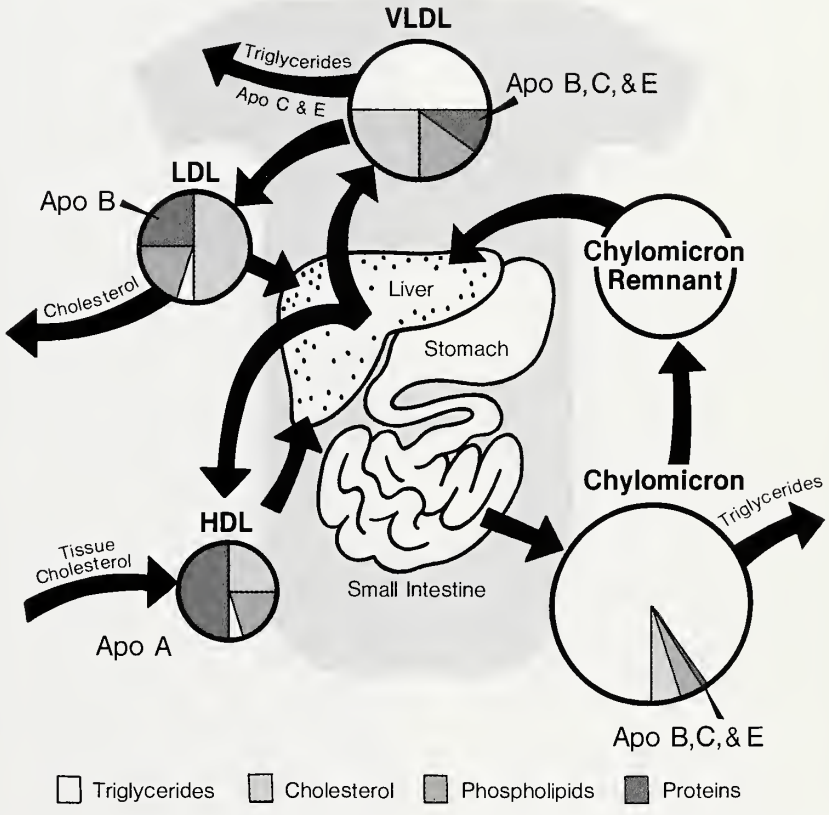
Dietary lipids (fats and cholesterol) come in three forms: triglycerides, the most common of the food lipids, which contain saturated and unsaturated fatty acids; phospholipids, which are similar in structure to triglycerides; and cholesterol, which has a much different structure. Once absorbed into intestinal cells, lipids are packaged into oversized lipoproteins called chylomicrons, containing about 90 percent triglycerides.

En route to the liver, chylomicrons release much of their triglyceride cargo to fat storage tissue and become smaller chylomicron remnants.

In the liver, lipids are repackaged into very lightweight and heavyweight lipoproteins: VLDL's are mostly lipid and therefore very low density; HDL's are half protein and therefore higher density.

As the name implies, all lipoproteins contain proteins—called apos for short—that perform several functions including helping the lipids dissolve in blood. But the types and proportions of apos differ among lipoproteins. ARS scientists are using this difference to develop a more accurate measurement of a person's lipoprotein profile and thus perhaps a key to his or her risk for coronary artery disease.

Like chylomicrons, VLDL's deliver triglycerides to storage tissue, and the two lipoproteins are responsible for those unwanted bulges at the waist, hips, and thighs when the supply exceeds the demand. In the process, VLDL's lose most of their triglycerides to become low-density lipoproteins, LDL's, with proportionately more protein. Now about half cholesterol, LDL's transport two-thirds of all the cholesterol in the blood. Diets high in saturated fat and cholesterol increase LDL levels, and the excess cholesterol gets dumped in unwanted places like artery walls. On the other hand, HDL's, with only about 20 percent cholesterol and room for more, pick up excess cholesterol and carry it back to the liver. HDL cholesterol is sometimes called the "good" cholesterol.



HDL's, VLDL's and chylomicrons apparently exchange both lipids and proteins throughout their journey in the bloodstream, but the process is not yet well understood.—**J.McB.**

Nation's Tallest "VAWT" Turning Out the Watts

Testing is now underway on the tallest and most powerful windmill of its kind in the United States. Known as a Vertical Axis Wind Turbine, or VAWT, it looks something like a giant eggbeater as it towers 164 feet above the flat terrain of the Texas Panhandle. It can produce 500 kilowatts of electricity every hour in a steady 28 mph wind.

"That's enough to run 20 farms or ranches or 100 homes," says R. Nolan Clark of the Agricultural Research Service's Conservation and Production Research Laboratory near Bushland, Texas, where the experimental turbine is located. It is the third VAWT to be tested at Bushland and is the first in the United States built for investigating VAWT aerodynamics and production of electricity on a large (500 kW and above) scale.

"That's [electricity] enough to run 20 farms or ranches or 100 homes."

R. Nolan Clark , Agricultural Research Service

Clark, an agricultural engineer, will monitor the VAWT's performance over the next 4 years as part of a windpower research project conducted jointly with the U.S. Department of Energy (DOE) and Sandia National Laboratories of Albuquerque, New Mexico. The turbine was designed and erected for DOE by Sandia.

"We're especially concerned about how well it will do in terms of providing a steady voltage" says Clark, who points out that automated feeding, milking, and irrigation systems on farms and ranches could be seriously disrupted by fluctuations in voltage and frequency.

"But keep in mind," he adds, "that this turbine is not a prototype for industry. There's a lot of technical innovation here that wind turbine manufacturers may want to adopt, but by and large this machine is meant for testing new concepts in vertical axis turbine design."

Like those before it, the latest VAWT at Bushland has two blades of aluminum bowed against a vertical shaft that rotates with the blades as the wind blows. Unlike its predecessors, however, the blade airfoils (blade cross sections) are shaped specifically for a vertical axis turbine instead of being copied from an airplane wing.

"You won't find blades like these on any other wind turbine," says Henry Dodd, head of Sandia's wind energy research division. "Their design allows the turbine to operate at peak efficiency over a broad range of windspeeds."

The blades, he points out, decrease in width and thickness as they curve away from the vertical shaft. This reduces aerodynamic drag at key points and helps the turbine maintain optimum rpm (revolutions per minute) in light winds. On the other hand, the thickness of the blades relative to their width has a stalling effect that helps slow the turbine when the winds are strong.

"We're not in a speed contest," says Dodd. "We want optimum rates of rotation for the production of electricity—nothing less, nothing more. If it rotates too fast, we've got problems."

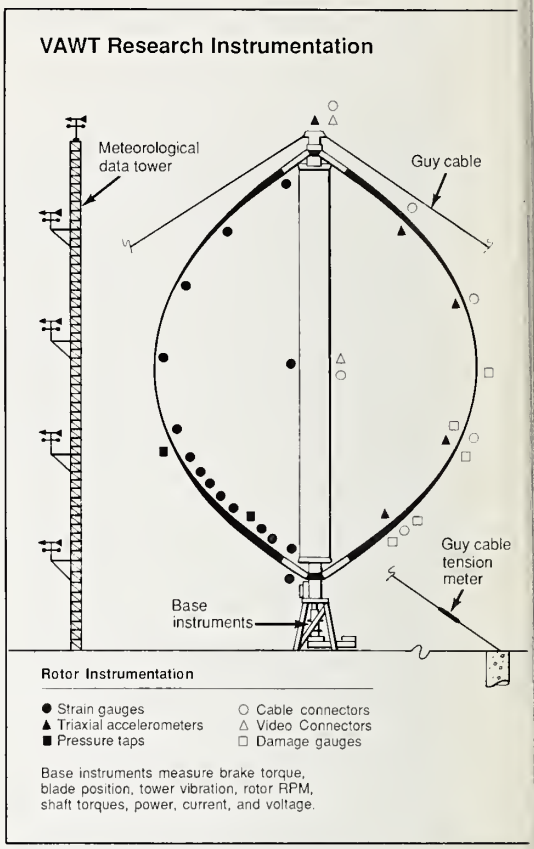
Rotating too fast, he says, could cause the turbine's support cables to snap as a result of excessive vibration. They could also lead to mechanical problems in the gears between the turbine and the electrical generator that it drives.

The turbine is designed to operate from 25 to 40 rpm with electronic circuits that stablize output frequency at 60 cycles per second.

Vertical axis wind turbines are not new. Their basic design was developed over 60 years ago, and they are now manufactured commercially by several firms. But the marketing experience of these firms has shown that modern VAWT's could be far more competitive, both in costs and energy production, with just a slight improvement in efficiency.

"The big advantage of the vertical axis design," says Dodd, "is that the conversion of rotating power to electricity occurs at ground level—at the base of the shaft. That's where the transmission, generator, brakes, and other mechanical connections are located. It makes their installation a whole lot easier, not to mention their maintenance and repair."

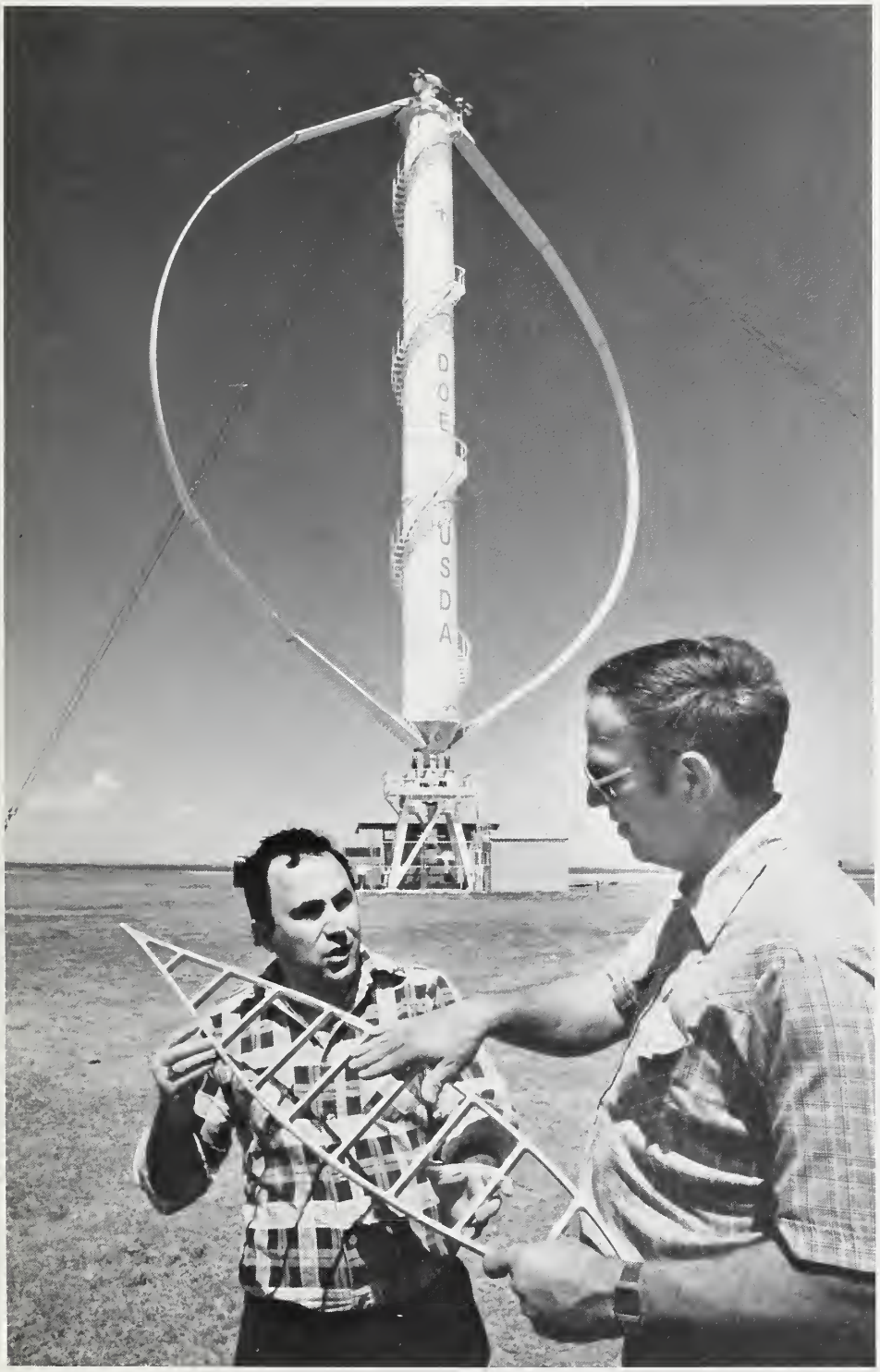
The Bushland VAWT is connected to a generator, which is essentially an array of powerful magnets inside huge coils of wire. When the magnets rotate, the result is electricity.



JOHN EBLING

"We use the same type of generator that's found in electric power plants using coal, oil, or even nuclear fission," Dodd says. "In this case, the energy to turn the magnets comes from the wind."

And the amount of energy in the wind is considerable. In the Great Plains, where the wind averages about 14 mph, it packs a potential 200 to 300 watts for every square meter that it blows against. The VAWT at Bushland has an effective surface area of 955 square meters and is



JOHN EBLING

Above: Agricultural engineers Nolan Clark (right) and Fadi Kamand discuss cross section of the blade designed specifically for the 164-foot-tall vertical axis wind turbine in background. (88BW0645-24A)

Left: Electronic instrumentation that measures cable tension is calibrated by agricultural engineer Ron Davis. Information from each of the wind turbine's three guy cables is fed to a data acquisition center for processing. Continuous monitoring of cable tension enables engineers to make adjustments to avoid vibration caused by windspeed and temperature changes. (88BW0646-27A)

able to convert about 40 percent of the wind's force into electricity.

"Actually, this type of VAWT—one this big—produces far too much power for just one farm or ranch," says Nolan Clark, "and it would probably be too expensive as well. As far as ownership and use is concerned, small co-ops might be the only way to go."

Then why so big? Why not smaller turbines for individual farms?

"We really believe this is the most efficient size, all things considered," answers Henry Dodd. "It's a combination of aerodynamic principles, structural requirements, and costs."

The blades on the turbine, Dodd says, have to be wide enough to create the necessary lift and have to be far enough apart to create the torque or leverage needed to turn the central shaft. The distance they curve out from the shaft—the maximum diameter of the turbine—also governs the turbine's height.

"You can't just scale these things down," he says. "Make the turbine a little smaller and you wind up losing a lot of aerodynamic efficiency and a lot of power with only negligible savings in construction costs."

What about the surplus electricity?

"That can be sold back to the local utility," says Clark, "assuming that it's a clean and steady voltage. Wind turbines are already tied into power company lines in some states, but their initial costs are usually too high to make a profit. We expect our turbine here at Bushland to do a lot better."

As part of its overall testing program, the turbine will supply electricity to automated water pumps used in irrigation research at Bushland. Excess power will go to the Southwestern Public Service Co. for the area power system.

"Our tests will answer a lot of questions about the safety, effectiveness, and economy of wind-generated electricity," says Clark. "They will provide the kind of data farmers and ranchers and entire communities need in deciding whether or not wind turbines of this size and design are right for them."—By **Steve Miller,** ARS.

R. Nolan Clark is at the USDA-ARS Conservation and Production Research Laboratory, P.O. Drawer 10, Bushland, TX 79012 (806) 378-5734. ♦

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PATENTS

Moisture-Shrinkable Films

The United States today produces more than 6 billion pounds of plastic film each year. An important segment of that market is shrink films, now widely used in the packaging industry. After items are wrapped in these familiar thermoplastic wraps, they are exposed briefly to heat, which causes the film to contract.

But there's more than one way to shrink a film, providing that it's made of starch-poly(methyl acrylate) graft copolymers prepared from hot water-soluble modified starches. It's recently been found that these starch graft copolymers can be processed to produce films that are moisture-shrinkable. They remain dimensionally stable at low-to-moderate relative humidities but shrink when exposed to relative humidities approaching 100 percent.

When placed around irregularly shaped objects, moisture-shrinkable films conform within a few minutes to the object shape without forming stress cracks. When the time comes to remove an item from its packaging, the film can be dissolved easily by soaking the encapsulated object for a few minutes in water.

The film may be suitable for enclosing and protecting highly polished or abrasion-sensitive objects such as glassware, dishes, tools, and scientific instruments. Another potential use is for individually sealed pieces of fruit and other food products.

For technical information, contact George F. Fanta, USDA-ARS Northern Regional Research Center, 1815 N. University St., Peoria, IL 61603. Patent Application Serial No. 07/123,411, *"Moisture-Shrinkable Films From Starch Graft Copolymers."*

Removing Endotoxin From Cotton

Potentially dangerous bacterial substances adhering to raw cotton can be safely removed before processing by treatment with certain solvents.

These bacterial substances—endotoxins—have been implicated as a cause of byssinosis, a lung disease that can afflict cotton textile workers. The toxins are found in the cell walls of some gram-negative bacteria commonly found in cotton fiber and plant parts, and have been identified in the atmosphere of textile mills processing cotton fibers.

Currently, filters are used to keep cotton dust to acceptable levels. Washing at high temperatures and steaming were used in the past to reduce endotoxin in cotton lint. Although considered effective, this left cotton less suitable for manufacture.

The new method is based on the discovery that endotoxin molecules can be deactivated by de-esterification of certain long chain fatty acid groups.

Three solvents can detoxify raw cotton or cotton dust containing endotoxin: 95 percent ethyl alcohol containing sodium hydroxide or hydrochloric acid or dimethylsulfoxide. After treatment, the solvent is extracted from the cotton by filtration, centrifugation, or other means.

For technical information, contact Linda N. Domelsmith, USDA-ARS Southern Regional Research Center, P.O. Box 19687, Room 1129, New Orleans, LA 70179. Patent Application Serial No. 07/068,497, *"Method for Reduction of Endotoxin in Cotton Lint or Dust."*

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Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks Office, Washington, DC 20231. Copies of pending patents may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. ♦